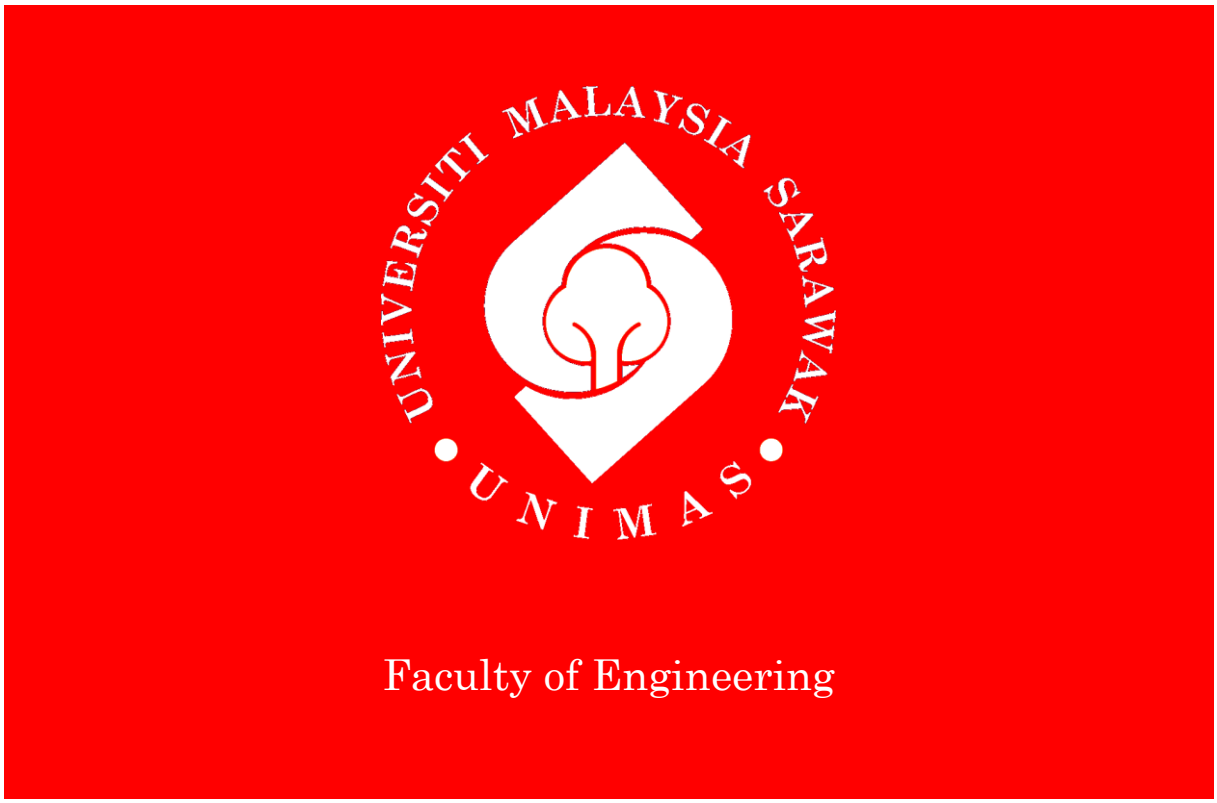

QUEUE MANAGEMENT SYSTEM

EILEEN LIAW CHUEN ING

Bachelor of Engineering (Hons) in
Electronics (Telecommunications)
2018

UNIVERSITI MALAYSIA SARAWAK

Grade: _____

Please tick (√)

Final Year Project Report ☑

Masters ☐

PhD ☐

DECLARATION OF ORIGINAL WORK

This declaration is made on the ....14th.....day of....June.....2018.

Student's Declaration:

I EILEEN LIAW CHUEN ING, 46686 from FACULTY OF ENGINEERING

(PLEASE INDICATE STUDENT'S NAME, MATRIC NO. AND FACULTY) hereby declare that the work entitled QUEUE MANAGEMENT SYSTEM is my original work. I have not copied from any other students' work or from any other sources except where due reference or acknowledgement is made explicitly in the text, nor has any part been written for me by another person.

14/06/2018
Date submitted

EILEEN LIAW CHUEN ING (46686)
Name of the student (Matric No.)

Supervisor's Declaration:

I Dr Shafida Sahrani (SUPERVISOR'S NAME) hereby certifies that the work entitled QUEUE MANAGEMENT SYSTEM (TITLE) was prepared by the above named student, and was submitted to the "FACULTY" as a * partial/full fulfillment for the conferment of ENGINEERING IN ELECTRONICS (TELECOMMUNICATIONS) (PLEASE INDICATE THE DEGREE), and the aforementioned work, to the best of my knowledge, is the said student's work.

Received for examination by: Dr Shafida Sahrani Date: 14/06/2018
(Name of the supervisor)

I declare that Project/Thesis is classified as (Please tick (√)):

☐ **CONFIDENTIAL** (Contains confidential information under the Official Secret Act 1972)*
☐ **RESTRICTED** (Contains restricted information as specified by the organisation where research was done)*
☑ **OPEN ACCESS**

Validation of Project/Thesis

I therefore duly affirmed with free consent and willingness declare that this said Project/Thesis shall be placed officially in the Centre for Academic Information Services with the abiding interest and rights as follows:

- This Project/Thesis is the sole legal property of Universiti Malaysia Sarawak (UNIMAS).
- The Centre for Academic Information Services has the lawful right to make copies for the purpose of academic and research only and not for other purpose.
- The Centre for Academic Information Services has the lawful right to digitalise the content for the Local Content Database.
- The Centre for Academic Information Services has the lawful right to make copies of the Project/Thesis for academic exchange between Higher Learning Institute.
- No dispute or any claim shall arise from the student itself neither third party on this Project/Thesis once it becomes the sole property of UNIMAS.
- This Project/Thesis or any material, data and information related to it shall not be distributed, published or disclosed to any party by the student except with UNIMAS permission.

Student signature _____ (Date)

Supervisor signature: _____ (Date)

Current Address:
575, LORONG 24B, JALAN CANNA, TABUAN TRANQUILITY, 93350 KUCHING, SARAWAK.

Notes: * If the Project/Thesis is **CONFIDENTIAL** or **RESTRICTED**, please attach together as annexure a letter from the organisation with the period and reasons of confidentiality and restriction.

[The instrument is duly prepared by The Centre for Academic Information Services]

QUEUE MANAGEMENT SYSTEM

EILEEN LIAW CHUEN ING

A dissertation submitted in partial fulfilment
of the requirement for the degree of
Bachelor of Engineering with Honours
(Electronics Telecommunications Engineering)

Faculty of Engineering
Universiti Malaysia Sarawak

2018

To my beloved family and friends.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude and special thanks to my supervisor, Dr. Shafrida binti Sahrani of Universiti Malaysia Sarawak from Electronics and Electrical Engineering department for her countless support and guidance throughout the progress and development of my final year project. Without her inspirations and supervision, this thesis could not have been completed. Besides that, I would also like to extend my gratitude to my beloved family members for their endless love, encouragement and support throughout the completion of my four-year undergraduate study. With their unshaken trusts and motivations, I weathered through all the downs and falls in finishing my degree life. Not to forget, special thanks to my friends especially my course mates for their helps, motivations and also advices during the four years of study. Thank you too for lending hands whenever I needed them during the progress of this project. Lastly, I would like to express my gratitude towards those who helped me directly and indirectly throughout my undergraduate study including making this project a success. I sincerely wish everyone to be blessed always and have the best of everything now and then.

ABSTRACT

Queue management system is a device to ease customers' flows by reducing the waiting time and increasing the efficiency of queuing. The current queuing systems at those highly populated compounds such as general hospitals are still focusing more onto conventional method. Customers are required to go to the specified premises in advance to be allowed for a turn after taking the tickets. Hence, it gives rise to the potential of unpredictable waiting time resulting in dissatisfaction from the customers. Therefore, it is very important to reduce time spent on queuing with dependable estimation time and improve the applicable queuing techniques. The proposed queue management system in this project is designed by taking the latest trends of mobile application usage into higher consideration. The number of citizens within all range of ages owning smartphones are also escalated from year to year. Thus, the system proposed made up of a programmed Arduino Uno board as the microcontroller using C++ programming language and compiled in Arduino Software (IDE) to control the flow of customers on mobile queuing. The Arduino Uno is shielded with an ESP8266 Wi-Fi shield and it connects with the Android-based mobile apps developed through a publicly accessible server by using the Internet application. Both Arduino Uno and the mobile apps will communicate by using the server. The main centralized type of queuing is the online queuing that being requested by consumers through their mobile applications on the smartphones. Furthermore, text queuing method implementing through the Short Messaging System (SMS) application is added to increase the reliability of the proposed system and to enhance the queuing efficiency of the users. GSM SIM800L is connected to the Arduino Uno to control the process of sending and receiving texts. The proposed design combines both the wireless and GSM connections thus providing limitless coverage range for the users to access the queue management system.

ABSTRAK

Sistem pengurusan giliran digunakan untuk melancarkan pergerakan para pelanggan bagi mengurangkan tempoh menunggu dan meningkatkan kecekapan perbarisan. Sistem sedia ada yang digunakan di tempat-tempat yang padat dengan populasi pelanggan seperti hospital umum masih menitikberatkan pengamalan kaedah konvensional. Melalui kaedah ini, para pelanggan dikehendaki ke premis yang diingini terdahulu untuk mengambil tiket di kaunter yang disediakan. Ini menyebabkan masa menunggu tidak dapat diramal yang boleh menimbulkan ketidakpuasan daripada pelanggan. Justeru, masa yang dihabiskan untuk beratur harus dikurangkan dengan menyediakan anggaran masa yang boleh dirujuk serta memperbaiki teknik-teknik beratur yang dapat diaplikasikan. Sistem pengurusan giliran yang dicadangkan dalam projek ini direka dengan mengambil kira arah aliran terkini yang mengutamakan penggunaan aplikasi mudah alih. Bilangan pengguna yang memiliki telefon pintar tanpa mengira lingkungan umur juga meningkat saban tahun. Oleh itu, sistem yang dicadangkan terdiri daripada Arduino Uno yang berperanan sebagai mikropengawal diprogramkan menggunakan bahasa pengaturcaraan C++ dan dikumpul dalam *Arduino Software (IDE)* untuk mengawal aliran para pelanggan. *Cytron ESP Wi-Fi Shield* diletakkan di atas papan Arduino untuk menghubungkan Uno tersebut dengan aplikasi mudah alih berasaskan Android yang dibangunkan melalui pelayan yang boleh diakses secara umum menggunakan aplikasi Internet. Arduino Uno dan aplikasi mudah alih Android yang direka akan berkomunikasi menggunakan pelayan tersebut. Fokus utama projek ini adalah untuk mengawal giliran para pelanggan melalui sistem aplikasi mudah alih yang telah dimuat turun pada telefon pintar. Selain itu, cara pengawalan pergerakan para pengguna melalui kaedah pesanan ringkas ditambahkan ke dalam sistem pengurusan giliran ini untuk meningkatkan keupayaan dan kecekapan sistem yang dihasilkan. GSM SIM800L disambungkan ke Arduino Uno untuk mengawal proses penghantaran dan penerimaan teks. Reka bentuk yang dicadangkan menyediakan jangkauan liputan meluas untuk pengguna mengakses sistem pengurusan giliran dengan menggabungkan kedua-dua penggunaan wayarles serta GSM.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BLE	-	Bluetooth Low Energy
CLK	-	Clock
DC	-	Direct Current
DIO	-	Data Input-Output
FIFO	-	First In, First Out
GND	-	Ground
GPIO	-	General Purpose Input Output
GSM	-	Global System for Mobile Communication
HTTP	-	HyperText Transfer Protocol
IC	-	Integrated Circuit
ICSP	-	In-Circuit Serial Programming
IDE	-	Integrated Development Environment
IoT	-	Internet of Things
LED	-	Light-Emitting Diode
LIFO	-	Last In, First Out
PWM	-	Pulse Width Modulation
QMS	-	Queue Management System
RX	-	Receiver
SCL	-	Serial Clock
SDA	-	Serial Data Access
SIRO	-	Service in Random Order
SMS	-	Short Message System
SSID	-	Service Set Identifier
TX	-	Transmitter
USB	-	Universal Serial Bus
VCC	-	Voltage at the Common Collector
Wi-Fi	-	Wireless Fidelity
ZIP	-	Compressed File

CHAPTER 1

INTRODUCTION

1.1 Overview

Queue is best defined as proper arrangement in a systematic order waiting turn to be served. The process of directing customers to a specific required service from a central location describes queuing. Queues of people can be encountered everywhere especially during the peak hours starting early in the morning from half past eight at the service sectors such as at the general post office and local banks. Due to the ineffectiveness of customer service management, they need to wait for quite a duration of time to get their services done. Thus, a systematic and effective queue management system is needed in order to control the queues. The following section will outline the background of queue management system (QMS), types of queuing, statement of problems, project aim, objectives, the project's scopes, expected outcomes of the project done and the project outline for this report.

1.1.1 Background

The late Secretary General of the United Nations; Kofi Annan termed the countries with secure environment providing people free healthy life as developed country [1]. In the industrialized [2] and newly industrialized countries [3]-[6] such as the United States [7] in northern America and Japan [7] in Asia [8], service-oriented businesses cover most of the economy sector. It is being defined as the providers of services to the customers.

According to the East End Fair Finance Ltd, authorised and regulated by the Financial Conduct Authority of the United Kingdom, the service industries accounted for seventy four percent of businesses, seventy nine percent of employment and seventy one

percent of turnover. Services can either be supplied by the private sector or government sector. There are many general service-oriented organizations that needed by the customers such as banks, hospitals and post offices.

In term of the customer flow management, Malaysia [9] is one of the most organized countries as advanced queue management systems were installed in the organizations according to Wavetec, the global leader in delivering customer experiences solutions [10]. Other than Wavetec, the Queue Management product by VisCon Systems Sdn. Bhd. [11] which is one of the local companies since 2000 has been installed widely in various sector of services such as health care, banking, education and telco in Malaysia [9]. To be specific, few of the clients are Klinik 1Malaysia, Bank Simpanan Nasional and Pos Malaysia.

1.1.2 Types of Queuing

The service industry uses various type of queuing techniques in order to increase better efficiency and performance in operation's productivity. Queuing techniques are the systems implemented by specific company to provide an orderly manner of service to the customers. In this project, mobile queuing is proposed to reduce the long waiting time besides enhance the queuing efficiency in the service sector. Mobile queuing will be further divided into text queuing and online queuing focusing on mobile apps. Basically, the queuing methods consisted of waiting lobby, reservations, online queuing and telephone queuing.

First, the basic queuing system introduced in the retail service organizations such as polyclinics, general hospitals and hair salons is the waiting lobby method. This method is similar to static queue. The customers are required to enter the premise and sign in for desired services then wait for their turn. It is troublesome as the waiting time cannot be predicted and some of the premises' compound are limited. There is possibility that customer's missed the turn after leaving the packed lobby and waited nearby.

Reservations method is very unique and only offered by some of the service businesses such as private clinics, spas and upscale dining establishments. In the other word, this technique requires the customer to make an appointment or booking earlier before having the services. The advantage of reservation method is that the customer does not need to wait and have their own specified slots of time. For example, making an appointment with the specialist for treatments and consultants is a better choice when the

customer is having severe health issue to avoid uncomfortable surrounding of the packed waiting space provided.

As more and more people are using smartphones, online queuing is being introduced by online services and many premises such as banks and airlines services. The customers are queued in virtual line by setting the appointments through the specified applications installed on their phones. This flow of customer requests is controlled by the developed online queuing systems according to the selected services and important details such as the number of customer's turn including the current number of the queue are stated on the user's phone.

The fast food delivery companies are the best example for the telephone queuing. The most popular delivery amongst the Malaysian is the Pizza Hut Delivery as it covers all ages. Even students stay in the colleges get used to make a pizza hut delivery service order through their phones by calls and through online page. This kind of method set the phones as the essential requirement for the service models to get through with the customers. The main advantage of telephone queuing compared to the online queuing is that, smartphones is not a must and Wi-Fi connection or cellular data is not needed for online purposes.

1.2 Problem Statement

For the service-based businesses, systematic and efficient queue management system is one of the best approaches in achieving customers' satisfaction, at the same time providing the excellence services to the customers. Besides, queues of people convey the sign of an incapability of the organizations to others. The frustration and anger from customers due to unpredictable waiting time should be avoided as this will affect the impression of them on the companies [12]. According to Kandemir-Cavas and Cavas (2007), it is a norm for people to queue in line for a service when it goes beyond its supply.

However, until today, long waiting time is still a severe issue in the services sector for the customers to get their services done. Taking the clinical department as an example, the average patient discharge time is three hours according to Dr Chin Zin Hing, Director of Sarawak General Hospital which is quoted from the Metro News on Thursday, 3 November 2016 [13]. Due to the long waiting time arises, thus the current queue management method is analysed to be ineffective in terms of the high costs, inconsistent waiting time and poor performances. Thus, an advance automated queuing management

system which can improve the traditional queuing system and connect through mobile phones via Short Message Service (SMS) and mobile apps following current trend should be developed.

1.3 Project Aim

The main aim for this project is to reduce the waiting time spends by users to get their services done. Besides that, it is to increase the efficiency of queuing by designing and developing better Arduino-based queuing system.

1.4 Objectives

In order to reduce the time of in line queuing and improve the current queue management system available in the service-based premises, the objectives of this project are:

(a) To investigate the issue of long waiting time in services sector
(b) To design an efficient management system for different types of queuing
(c) To develop a functioning automated queuing management system for general purpose use

1.5 Scope of Project

The scope of this project is to design and develop a working automated queuing management system. This Arduino-based project is designed for general purpose use to control mobile queuing. The mobile queuing is further divided into two different categories which are text queuing through SMS and online queuing through online application. There will be two counters set in this system to control each type of the queuing. The current state of queue will be displayed on the programmed TM1637 light-emitting diode (LED) display and online application display. Different type of LED displays can be connected to the Arduino with its specific connections and codes programmed. The number of turn of the applicant and current state of queue will be included in the SMS delivered to phone by Global System for Mobile Communication (GSM). Besides, the number of turn for the customer will also be displayed on the mobile interface for those applying for queue through the online queueing apps along with the current number of queue to be served.

1.6 Expected Outcomes

Upon the completion of this project, the expected outcomes are:

(a) Gain new knowledge in recent technology on the queuing management system and have a clearer view on current scenario of long waiting time in the services sector such as bank, general hospital and others.

(b) Design an improved Arduino-based system on automated queuing management.

(c) Develop a working prototype for general purpose queuing system.

1.7 Project Report Outline

This report contains five chapters altogether include this chapter and the brief description of each chapter are outlined as below:

Chapter 1 covers the overview of the project as the background of service-based business is introduced along with the basic types of queuing in the queue management system. This chapter also focuses on the problem statement, project aim, objectives, scope of project, expected outcome and the project outlines.

Chapter 2 describes the literature review of the designed project on the queuing theory along with the queuing rule of thumb and types of queue discipline. The basic queue management system concepts that consist of human management, ticket-based management, physical management, sign-in sheet and the digital management is discussed then followed by the listing with descriptions on existing queue management products in the market to be the design's guidelines and the previous study on queue management system to be considered for the improvement on this project.

Chapter 3 discusses about the methodologies used in this project. The steps involves software development of the Arduino Uno and the hardware designs for the queue management system designed. The components used with its descriptions of functions and the list of components for the carried out project were further discussed and explained in this chapter.

Chapter 4 analyses the results obtained along with in-depth discussions and explanations. The analysis done focusing more on the compilation of the program and the outputted result from the system designed. Surfaced errors were being determined and discussed. The reliability and performance of the developed queuing system is also being analysed.

Chapter 5 discusses the conclusion of the system development and summarises the achieved data on the project done. Besides that, the recommendations for future improvement were being proposed and discussed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Queues of people can be observed everywhere and anytime at the service industry's premises. Customers even queue to wait for their meal to be served in the food courts and restaurants. In Malaysia [9], there are cases of the airlines services' customers missed their flights due to the long hours of queue while waiting for the check-in process at the service counters. The main element in handling queues and solving the waiting time of customers is the queue management system applied by the company itself. The functionality and productivity of this system is vital in controlling the effectiveness of the customers' flow. Services at any company will be rated as excellence by the users if the waiting time is less. The following section will outline the queuing theory [14], queue management system (QMS), existing queue management product in service industry, previous study on queue management system and the summary of this chapter.

2.2 Queuing Theory

The statistical study of queues was first being researched by the Danish mathematician, statistician and engineer; Agner Krarup Erlang [15]. This study is known as queuing theory [14] and it is basically a branch of operation research. The prototypes are designed to represent the Copenhagen telephone exchange [15] and published the related paper in the year of 1909 [16]. This theory can be applied widely in many situations either virtually or in reality. The examples are waiting for a paying bill at the malls, queuing for the public transportations and customers waiting for the online service

providers to response through mails on the computers. Generally, the queue management system can be illustrated into few discrete smaller systems as shown in Figure 2.1.

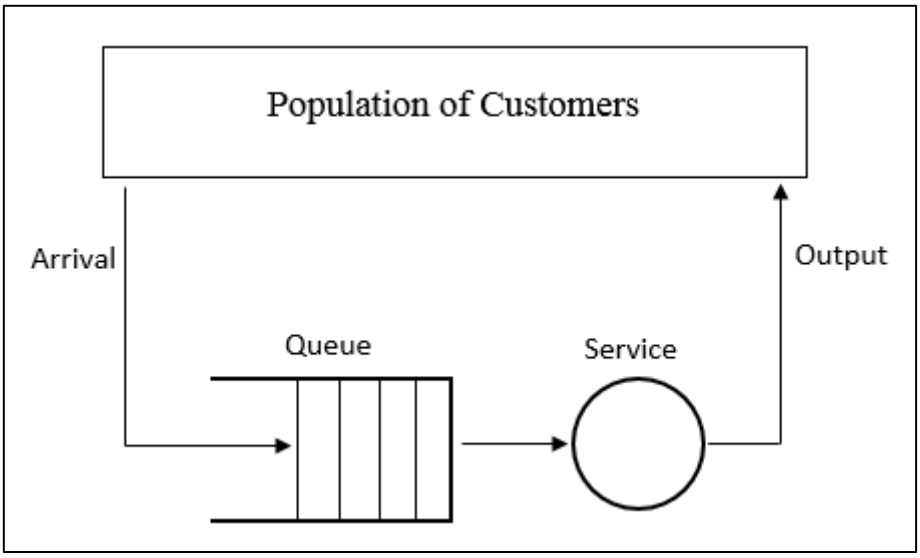

Figure 2.1: Single Queue Management System [17]

2.2.1 Queuing Rule of Thumb

The term used to describe number of customers able to be served is the population of customers. It can be categorized into two types; limited and unlimited depending on the services provided by the companies. The limited type refers to services with specific allocation of spaces such as the public transportations. Services with unrestricted total of customers is for the unlimited population such as the hospitals and banks. An easy mathematical expression known as the Queuing Rule of Thumb [18] , [19] can be applied to estimate the optimum number of counters needed to be provided in any premise. The rule's formula [18] , [19] is:

$$s > \frac{Nr}{T} \qquad (2.1)$$

where s is the number of servers, N is the total number of customers, r is the service time and T is the maximum time to finish the queue.